

Appendix E

Noise Modeling Results

This appendix contains the results of the noise modeling effort for the EA

APPENDIX E

MAP NOISE MODELING TECHNICAL REPORT

This report provides detailed information related to the noise results disclosed in **Chapter 4, Environmental Consequences**, the methodology used in preparing the noise analysis, statistical information used in the development of the predicted noise levels, and information related to the impact of noise on people located within the MAP Study Area. The organization of this report is threefold:

- Describe the noise modeling analysis objectives and technical protocol.
- Identify data input assumptions and procedures.
- Disclose noise impact results and identify major contributors of change in noise impacts.

E-1 KEY NOISE MODELING ASSUMPTIONS

A critical aspect of the MAP noise modeling process is the integration of the airspace and operational delay modeling (Using the Total Airport and Airspace Model – TAAM) with the noise evaluation. For this analysis, the following are key modeling assumptions considered prior to developing the model input data:

- The design day flight schedules developed and used for both the TAAM and Noise Integrated Routing System (NIRS) analysis contained the same number of operations and the same fleet mix.
- The design day flight schedule was based on the 2003 Federal Aviation Administration's Terminal Area Forecast for STL and the

forecasts presented in Appendix B, Aviation Activity Forecasts.

- The Delay & Travel Time TAAM analysis provided the general flight routing and day/night distribution for the NIRS modeling.

E-2 NOISE ANALYSIS OBJECTIVES

The St. Louis airspace presents a unique but generally straightforward exercise in noise modeling due to its limited operating configurations. However, due to the size of the study area, and the number and variety of aircraft entering and exiting the STL area airspace, over 70,000 radar flight tracks were evaluated as part of the noise model input development. The following objectives outlined from **Sections 2.1 through 2.9** were determined to insure a detailed and accurate assessment of modeling noise exposure throughout the study area. The process of meeting the following objectives is discussed in **Section E.3** of this appendix.

E-2.1 Evaluate Changes in Noise Levels

For aviation noise analysis, FAA requires that the cumulative noise energy exposure of individuals to noise resulting from the operation of an airport be established in terms of yearly day/night average sound level (DNL). For purposes of this study, a detailed noise analysis is considered appropriate. Therefore, the FAA-approved Noise Integrated Routing System (NIRS) noise model program, using standard data provided by FAA's Integrated Noise Model (INM), was utilized in modeling cumulative noise exposure. (For a detailed description, refer to Section E.3.1.)

Noise exposure contours were not calculated for this study because the computer model normally used to assess noise impacts (INM) cannot be applied to widespread areas; nor can this model evaluate high-altitude flight route changes. Noise exposure contours only describe noise impacts in the immediate vicinity of airports (three to five miles). The FAA's NIRS model provides a more detailed modeling tool to evaluate the effects of high-altitude airspace changes from the ground level to 18,000 feet Above Field Elevation (AFE) on noise-sensitive areas, and to determine whether more detailed analysis would be required.

The following scenarios were evaluated:

- 2006 Future baseline – existing airspace and routes (adjusted for inclusion of the new W1W runway).
- 2006 Alternative 4a – Alternative 4a changes (True 4-Corners).
- 2006 Alternative 6 – Alternative 6 changes (Dual Arrivals-Keep-em High).
- 2006 Alternative 10 – Alternative 10 changes (Hybrid).
- 2013 Future baseline – existing airspace and routes (adjusted for inclusion of the new W1W runway).
- 2013 Alternative 4a – Alternative 4a changes (True 4-Corners).
- 2013 Alternative 6 – Alternative 6 changes (Dual Arrivals-Keep-em High).
- 2013 Alternative 10 – Alternative 10 changes (Hybrid).

Information disclosed in this study includes the number of people within predefined noise exposure ranges, including any resulting net increases or decreases in the number of people exposed to that level of noise for the scenarios previously listed.

E-2.2 Model All Traffic Routes Over Entire Study Area

Over 70,000 radar flight tracks were used to evaluate and model typical flight routes and flows throughout the St. Louis metropolitan airspace. Of these tracks, some 28,000 represented overflights of the Study Area while approximately 41,900 represented the arrival and departure activity at the five airports included in the modeling.

E-2.3 Model Day/Night Noise Levels at Population Centroids

Within the study area, 80,562 population centroids were evaluated with a total population of 3,627,957. The smallest centroid has a population of one, and the largest centroid has a population of 3,902. Census data for 2000 serves as the source for the centroid information and population projections were developed for the future years of analysis. For each of the eight modeling scenarios, yearly day/night average sound levels were calculated for all population centroids within the Study Area based on 2000 Census data.

E-2.4 Model Day/Night Noise Levels at Selected 4f and 6f Locations

An additional grid point analysis was performed to evaluate noise levels at 4f and 6f sites within the Study Area. These sites were initially identified as single point locations within the Study Area. In some cases, the 4f and/or 6f lands covered a large area (usually large parks or wilderness areas) that was not well represented by a single point of analysis. In these cases a uniformly spaced grid of points was defined over each area to provide adequate coverage.

E-2.5 Model Day/Night Noise Levels at Supplemental Grid points

In case there were areas of change not adequately represented by the population centroid points or the 4f/6f points, an additional grid point analysis was performed on a uniform rectangular grid array throughout the MAP study

area. The points of evaluation for this grid were spaced at one mile intervals. These grid points serve primarily as indicators of noise exposure in areas that have little or no population centroids.

E-2.6 Utilize Standard Procedure Profiles with ATC Altitude Control Points

Aircraft within the St. Louis area operate in accordance with standardized air traffic control procedures. To model existing and proposed procedures, arrival and departure profiles were designed to meet certain altitude restrictions above 3,000 feet AFE as set by air traffic control, and to use standard procedure profile data provided by INM below 3,000 feet AFE.

E-2.7 Identify and Quantify Noise Impact Changes and Causes Thereof

DNL noise exposure levels are reported for each centroid and grid point, change is quantified, and the causes of change in noise exposure are explained. Criteria set to meet this objective are described in **Section 3, “Noise Modeling and Analysis.”**

E-2.8 Produce Easily Interpretive and Informative Tables and Graphics to Report Results

The complexity (number of flight routes, airports, operations, etc.) of the study created challenges in reporting noise modeling results in a useful format for analysis. Tables and graphics were designed to be understandable to the public.

E-2.9 Noise Modeling Data Management

Due to the complexity and size of the data used to model noise impacts, a series of error checks were required to ensure accuracy. As such, database management tools were designed to allow for ease in analyzing and reporting results.

E-3 NOISE MODELING AND ANALYSIS

This section of the report describes the model used in the analysis, the data required for input into the model, noise model development procedures used, and the outputs from the modeling process. **Sections 4 and 5** provide the modeling results and analysis of those results.

E-3.1 Noise Model Program

Prior to the development of NIRS, limited technology was available to examine noise impacts associated with high-altitude air traffic changes. The FAA-accepted methodology to examine high altitude noise impacts was published in FAA Notice 7210.360, “Noise Screening for Certain Air Traffic Actions Above 3,000 Feet AGL,” on September 14, 1990. The process outlined in this notice was subsequently converted to the Air Traffic Noise Screening (ATNS) computer model v.1.0 in 1995. This model was further revised to its current form as v.2.0 in early 1999. However, the ATNS noise screening program was limited in its application because it could examine only one route at a time. The FAA recognized that there was a need to evaluate not only proposed multiple high altitude air traffic changes, but also the potential to create changes in noise levels at or below 3,000 feet when more efficient use of arrival and departure procedures are proposed. Consequently, the FAA expended considerable time, effort, and expense in combining airspace design criteria and noise modeling technology to examine the cumulative effect of multiple route changes and their effect on noise levels over a large geographical area containing multiple airports. The end product is a noise modeling program called the Noise Integrated Routing System (NIRS).

NIRS was initially developed in 1995 by the FAA Office of Environment and Energy (AEE-120), in cooperation with FAA Air Traffic for assessing regional airspace design. Its purpose is to assist the FAA in evaluating the environmental noise impacts of airspace routing and procedural alternatives designed to improve

system safety and efficiency. It is specifically tailored to evaluate complex air traffic applications involving high-altitude (up to 18,000 feet AFE) routing, broad area airspace changes affecting multiple airports, and other airspace modifications in the terminal and en route environments that cannot be assessed using other methods, most notably the Air Traffic Noise Screening Model (ATNS-7210.360) and the Integrated Noise Model (INM). NIRS evaluates noise impact by calculating the Day/Night Average Sound Levels (DNL) for specific locations on the ground, based on population centroids and grid points.^{1/} NIRS Version 1.0 was released in June, 1998 as a prototype model and Version 2.0 was released in December of 2001.

NIRS provides a powerful computational environment and graphical user interface, and provides the following major capabilities:

- Provides automated quantitative comparison of noise impacts across alternative airspace designs.
- Imports and displays track and operation data from airspace models, and population and community data from other sources.
- Enables user to specify air traffic control altitudes, and automatically calculates required aircraft thrusts and speeds necessary for noise using the same up-to-date database used for the FAA's Integrated Noise Model (INM).^{2/}

- Calculates predicted noise impacts at all population centroids (or other specially defined points) in large study areas.
- Provides automated means of annualizing noise impact based on different operational configurations and/or runway usage statistics.
- Identifies and maps all areas of change in noise impact.
- Identifies traffic elements that are the principal causes of change in noise impact in each area of change.
- Provides data for quantification of mitigation goals and identification of mitigation opportunities.
- Assembles tables and exhibits for noise-impact data analysis and report generation.
- Applies multiple layers of data checking and quality control.

NIRS was validated by the FAA's Office of Environment and Energy against the INM in 1997. This process involved providing both models with identical inputs, and performing a detailed comparison of the resulting outputs for representative jet, turboprop, and propeller aircraft for both arrival and departure operations. The models were found to give the same results in terms of both final noise values and intermediate aircraft state parameters (position, altitude, thrust, and speed). An on-going program ensures compatibility of the two models. Based on these results and on technical oversight of the NIRS development process, the FAA Office of Environment and Energy (AEE-120) has approved the use of NIRS for airspace applications.

The NIRS noise assessment methodology, interpretation guidelines, and population-impact results have been briefed at several levels throughout the FAA and U.S. Environmental Protection Agency (USEPA). In addition, FAA Air Traffic and AEE-120 assure that model integrity is maintained in terms of noise

^{1/} 2000 Census Data, U.S. Census Bureau.

^{2/} NIRS v.2.0 utilizes the INM 6.0 version database.

standards and equations, consistency with airport methodology, and reliability of use. NIRS is the best available tool to model noise exposure changes for a study of this magnitude and meet FAA's environmental responsibilities in an accurate and cost-effective manner.

E-3.2 Input Requirements

Noise modeling requires several types of input data: airport/runway locations, operational levels, day/night distributions, fleet mix, runway usage, noise-power-distance relationships, climb/descent profiles, aircraft weights, flight tracks, track dispersion information, population and grid locations, and boundaries of local jurisdictions. Details of the input data to NIRS for the MAP project are discussed below.

Airport and Runway Data

Five airports within the MAP study area were fully evaluated in this analysis. In addition, overflight traffic transiting the study area below 18,000' MSL altitude was also included in the modeling. STL was the major airport modeled and the reliever airports SUS, CPS, BLV, ALN were also modeled. All runways at these airports were assumed to be available for traffic assignments in NIRS, while at reliever airports at least one runway was assumed available for traffic. Standard approach slopes of three degrees were used for arrivals at all airports. The runways modeled are shown in **Table E-1**.

TABLE E-1 MODELED AIRPORTS			
Airport	State	Name	Modeled Runways
<i>Major:</i>			
STL	MO	Lambert-St. Louis International	12L/30R, 12R/30L, 6/24, 11/29(W1W)
<i>Satellite:</i>			
SUS	MO	Spirit of St. Louis	8L/26R, 8R/26L
CPS	IL	St. Louis Downtown	12L/30R, 12R/30L, 4/22
BLV	IL	MidAmerica/Scott AFB	14L/32R, 14R/32L
ALN	IL	St. Louis Regional	17/35, 11/29

Local Environmental Variables

In order to calculate noise levels specific to the conditions in the area of investigation, the NIRS model utilizes several local environmental variables. These include temperature, atmospheric pressure, humidity, airport average headwind, airport elevation, and terrain.

For this analysis 30 years (1974-2003) of hourly weather observations collected at STL were used to determine the long-term average weather conditions in the St. Louis area. **Table E-2** summarizes the weather data used for the NIRS analysis.

TABLE E-2 ENVIRONMENTAL VARIABLES – WEATHER	
Variable	Annual Average
Temperature (°F)	56.44
Barometric Pressure (in-Hg)	29.44
Relative Humidity (%)	69.24
Headwind (Kts)	8

Source: National Climatic Data Center (NCDC) Surface Airways data collected at Lambert-St. Louis International Airport. Averages of hourly observations CY1974-2003

The airport elevation for STL at 604' MSL was selected as the NIRS study elevation for the analysis. Detailed terrain data for the entire Study Area was incorporated from the United States Geological Survey (USGS) 1 degree Digital Elevation Model (DEM) database for the US. This database provides elevation data at ground points separated by 3 arc-seconds (approximately 250' east-west and 300' north-south in the STL area). The elevation values for each point are provided at a 1-meter resolution.

Operation Levels and Day/Night Distribution

Many aspects of this EA are based on the forecasts of future aviation activity. However, forecasts of aviation activity are expressed primarily at the annual level and, as such, are not well suited for use in most planning. The determination of future air traffic requirements calls for activity levels to be expressed at the

daily or hourly level. An efficient way to transition from the annual activity forecasts to the daily or hourly level is the use of the design day flight schedule.

Design day flight schedules, which are very similar in content to any airline flight schedule, contain information about the type of flight, arrival and departure times, the origin and destination of the flight (domestic or international), the operator of the flight, and the local airspace arrival and departure segments. These schedules were developed for the forecast 2006, and 2013 conditions. For this analysis, each schedule represents the average day (annual/365) of traffic for the year of interest. Each of the flight schedules were developed based on the forecasting effort undertaken for this study. **Appendix B, Aviation Activity Forecasts** presents the details of the analysis and the resulting forecasts for future activity in the MAP study area.

Runway Use

Generally, the primary factor determining runway use at an airport is the weather and prevailing wind conditions at the time of a flight. Additionally, several key secondary factors also have a strong influence on runway selection. These factors include runway safety issues (taxiing aircraft crossing active runways or Land and Hold Short-LAHSO rules), the current make up of the traffic (many arrivals or many departures), and even the flight's origin or destination. This latter factor is also based on safety from a standpoint that traffic is easier to sort on the ground (taxi for direction) than it is in the air.

Typically, arriving and departing aircraft are assigned to a specific fix. These fixes, in turn, have a primary arrival or departure runway assignment and a secondary arrival or departure runway assignment. As controllers attempt to balance delay and runway utilization by time of delay based on the demand, there are times when arriving and departing aircraft are diverted to a secondary runway. This allows the airfield to operate in the most efficient manner.

It is important to note that within the context of all of these factors, the future runway use at an airport is; at best, an estimate. Simple changes over time such as airlines changing the markets (destinations) that they serve can have a notable effect on actual runway use in the future.

Since STL is the primary airport within the study area, the runway use patterns used here determine how controllers move aircraft through MAP area airspace. Consequently, runway use patterns for other airports within the study area are based on how they relate to STL's runway use.

For STL, the runway use for the future conditions were primarily developed based on the runway utilization modeled in the FAA's EIS document for the W1W runway. These percentages from the EIS were combined with the projected design day schedules to develop

final runway use percentage estimates for the future conditions in 2006 and 2013.

Table E-3 presents the 2006 and 2013 modeled departure runway use percentages for STL based on the primary groups of aircraft. Generally, the runway use percentages are similar for 2006 and 2013; however some changes are evident resulting from the use of taxi-for-direction in conjunction with some new destinations expected in the future.

The estimated future runway use percentages for arrivals at STL are presented in **Table E-4**. Again, the arrival runway use percentages are similar for 2006 and 2013. Some variation is again evident due to changes in market service and destinations expected in the future.

TABLE E-3 STL DEPARTURE RUNWAY USE FOR NOISE MODELING								
Runway	Estimated Departure Runway Use – 2006							
	Commercial Jet		General Aviation Jet		Piston & Turboprops		Military	
	Day	Night	Day	Night	Day	Night	Day	Night
11	3%	3%	3%	4%	3%	5%	0%	0%
12L	6%	6%	6%	5%	20%	8%	31%	31%
12R	31%	31%	31%	31%	15%	27%	8%	8%
29	36%	35%	33%	38%	26%	45%	0%	0%
30L	22%	23%	26%	20%	32%	14%	12%	12%
30R	2%	2%	2%	2%	2%	1%	49%	49%
06	0%	0%	0%	0%	1%	0%	0%	0%
24	0%	0%	0%	0%	1%	1%	0%	0%
Total	100%	100%	100%	100%	100%	100%	100%	100%
Estimated Departure Runway Use - 2013								
11	3%	3%	3%	4%	3%	3%	0%	0%
12L	6%	6%	6%	6%	19%	20%	31%	31%
12R	31%	31%	31%	31%	15%	16%	8%	8%
29	36%	36%	33%	37%	26%	28%	0%	0%
30L	22%	22%	26%	21%	32%	30%	12%	12%
30R	2%	2%	2%	2%	2%	2%	49%	49%
06	0%	0%	0%	0%	1%	0%	0%	0%
24	0%	0%	0%	0%	1%	1%	0%	0%
Total	100%	100%	100%	100%	100%	100%	100%	100%

Source: FAA FEIS for W1W, Landrum & Brown Analysis, 2004

TABLE E-4 STL ARRIVAL RUNWAY USE FOR NOISE MODELING

Runway	Estimated Arrival Runway Use – 2006							
	Commercial Jet		General Aviation Jet		Piston & Turboprops		Military	
	Day	Night	Day	Night	Day	Night	Day	Night
11	22%	24%	22%	22%	18%	18%	0%	0%
12L	14%	13%	14%	15%	18%	18%	31%	31%
12R	2%	2%	2%	2%	2%	2%	8%	8%
29	5%	5%	5%	4%	5%	5%	0%	0%
30L	24%	27%	24%	23%	16%	16%	12%	12%
30R	28%	26%	28%	30%	16%	16%	49%	49%
06	2%	0%	2%	0%	2%	0%	0%	0%
24	3%	3%	3%	3%	23%	24%	0%	0%
Total	100%	100%	100%	100%	100%	100%	100%	100%
Runway	Estimated Arrival Runway Use - 2013							
	Day	Night	Day	Night	Day	Night	Day	Night
11	22%	25%	21%	28%	17%	24%	0%	0%
12L	14%	11%	15%	8%	19%	13%	31%	31%
12R	2%	2%	2%	2%	2%	2%	8%	8%
29	5%	6%	5%	9%	5%	7%	0%	0%
30L	24%	29%	23%	33%	15%	21%	12%	12%
30R	28%	25%	29%	18%	16%	18%	49%	49%
06	2%	0%	2%	0%	2%	0%	0%	0%
24	3%	2%	3%	2%	24%	16%	0%	0%
Total	100%	100%	100%	100%	100%	100%	100%	100%

Source: FAA FEIS for W1W, Landrum & Brown Analysis, 2004

The average annual runway use proportions at the satellite airports were developed from a 30 day sample of radar flight tracks for each airport. **Table E-5** presents a summary of the 2006 and 2013 modeled runway use percentages for each of the satellite airports modeled in the study.

Generally, the runway use percentages were held steady; however some changes are evident resulting from the use of taxi-for-direction in conjunction with some new destinations expected in the future.

TABLE E-5 SATELLITE AIRPORT ESTIMATED RUNWAY USE FOR NOISE MODELING								
Runway/Airport	Departures				Arrivals			
	2006		2013		2006		2013	
	Day	Night	Day	Night	Day	Night	Day	Night
SUS								
08L	1%	0%	1%	0%	1%	2%	1%	2%
08R	39%	37%	40%	37%	39%	33%	39%	36%
26L	58%	61%	56%	61%	58%	63%	58%	61%
26R	3%	2%	3%	2%	2%	1%	2%	1%
Total	100%	100%	100%	100%	100%	100%	100%	100%
ALN								
11	25%	0%	26%	0%	23%	23%	24%	0%
17	26%	50%	24%	50%	12%	12%	12%	33%
29	10%	0%	11%	0%	44%	44%	43%	67%
35	39%	50%	39%	50%	21%	21%	21%	0%
Total	100%	100%	100%	100%	100%	100%	100%	100%
BLV								
14L	13%	13%	13%	13%	22%	0%	24%	0%
14R	25%	25%	21%	21%	25%	50%	24%	50%
32L	37%	37%	43%	43%	39%	36%	32%	36%
32R	25%	25%	23%	23%	14%	14%	21%	14%
Total	100%	100%	100%	100%	100%	100%	100%	100%
CPS								
04	1%	1%	1%	1%	4%	12%	5%	8%
12L	0%	0%	0%	0%	0%	0%	0%	0%
12R	50%	77%	50%	75%	35%	31%	34%	34%
22	4%	8%	4%	8%	0%	12%	0%	10%
30L	44%	13%	44%	15%	58%	41%	58%	45%
30R	1%	0%	1%	0%	2%	4%	2%	3%
Total	100%	100%	100%	100%	100%	100%	100%	100%

Source: Landrum & Brown Analysis, 2004

Aircraft Fleet Mix

Fleet mix assumptions were developed for the MAP EA as part of the forecasting effort documented in **Appendix B, Aviation Activity Forecasts**. For STL, the operational forecasts were analyzed in conjunction with passenger enplanement forecasts, historic operational data, airline aircraft orders, and other information to develop a future fleet mix. **Table E-6** presents the forecast fleet mix for 2006 and 2013 for commercial, general aviation, and military

operations. As the table indicates, it is expected that the majority of commercial service in the future at STL will be provided by narrow body jet aircraft, primarily in the B-737 family. Regional Jet service will represent the second largest share of the commercial traffic, while propeller aircraft service is expected to continually decline throughout the forecast horizon. Few changes are expected in the general aviation and military fleet at STL through 2013.

TABLE E-6 FORECAST FLEET MIX - STL							
Category	Aircraft (NIRS Type)	2006	2013	Category	Aircraft (NIRS Type)	2006	2013
Commercial				General Aviation			
Jet	717200	2.2%	2.7%	Jet	737400	4.0%	3.7%
	737300	7.8%	7.9%		727EM2	8.1%	7.4%
	737700	29.6%	31.87%		CL600	21.2%	21.3%
	727EM2	0.5%	0.5%		CNA500	2.0%	1.9%
	A319	1.5%	1.9%		FAL20	6.1%	5.6%
	A320	0.9%	1.1%		GIIB	2.0%	1.9%
	BAE146	1.0%	0.00%		GIV	3.0%	3.7%
	CL600	4.4%	2.9%		LEAR25	2.0%	1.9%
	CL601(RJ)	24.9%	29.9%		LEAR35	7.1%	9.3%
	DC1030	0.4%	0.5%		MU3001	8.1%	7.4%
	DC870	0.2%	0.2%	Prop	BEC58P	20.2%	20.4%
	DC95HW	0.2%	0.34%		CNA441	8.1%	8.3%
	EMB145 (RJ)	7.9%	10.5%		GASEPF	4.0%	3.7%
	GV (RJ)	3.1%	2.5%		GASEPV	4.0%	3.7%
	MD83	4.4%	3.7%	Total		100.0%	100.0%
Prop	DHC6	3.1%	0.2%	Military			
	DHC8	3.2%	1.6%	Jet	F15A	100.0%	100.0%
	DHC830	0.7%	1.6%				
	SF340	3.8%	0.1%				
Total		100.0%	100.0%				

(RJ) = Regional Jet

Source: Landrum & Brown Analysis, 2003-04

A similar fleet mix analysis was also conducted for each of the satellite airports. Section 3.2 of Appendix B presents the forecasts and fleet mix for each of the satellite airports modeled for this analysis.

Aircraft Noise-Power-Distance (NPD) Curves

Both NIRS and INM use tables of sound exposure levels for specific aircraft and associated engines that determine how the sound level varies with the power setting of the engines and with the distance from the engine to the observer. These tables are termed noise-power-distance (NPD) curves. The NPD curves developed by the FAA for Release 6.0 of INM and Release 2.0 of NIRS were used in this analysis.

The NPD curves are accessed during NIRS noise calculations to determine the noise levels at each population or grid location. The contribution of each operation assigned to every flight track is calculated for every location depending on the power setting for each flight segment in each track, and upon the distance to the aircraft on each segment. The total noise exposure at each location is determined by aggregating the effects across all operations.^{3/4/}

Aircraft Climb/Descent Profiles

In order to accurately model noise exposure, NIRS has the capability to follow specified altitude restrictions incorporated in the flight track and operations data. The modeled aircraft trajectory in NIRS will reflect altitude information provided by the airspace designer, rather than following a standard procedure profile, as is ordinarily done in INM studies. NIRS automatically generates profiles for each aircraft operation on each flight track that are consistent both with the specified altitudes and the NIRS aircraft-performance database.

The altitude-following capability is only applied above altitudes of 3,000 feet above field elevation (3,604 feet MSL for this study).^{5/} This means that for all flight tracks that contain points with altitudes greater than 3,000 feet above field elevation (AFE), the NIRS standard procedure profile will be used up to 3,000 feet AFE. At higher altitudes, the profile will follow the specified air traffic control design. Four

types of altitude control have been encoded in the input files as follows: (1) no altitude control; (2) fly to a specified altitude or higher; (3) fly to a specified altitude; and (4) fly to a specified altitude or lower.

All routes are checked for violations of general profile constraints, such as maximum climb and descent angles. If necessary, the route is flagged for further modification to remedy such violations.

Once each profile meets all constraints, thrust is calculated according to whether the aircraft is climbing or descending along different parts of the route. NIRS climb calculations use maximum climb thrust from 10,000 feet to 18,000 feet AFE. NIRS descent calculations use a straight-line geometric descent from higher altitudes (i.e., above 6,000 feet AFE) as specified in the air traffic control design. Below 10,000 feet AFE for departures and below 6,000 feet AFE for arrivals, NIRS uses the thrusts required to fly the profile specified in the airspace design data.

Routes that have no altitudes higher than 3,000 feet AFE (3,604 feet MSL) are treated as special “low-altitude route” cases. They are processed as follows:

- Procedure 1. The highest altitude on a particular flight track is identified.
- Procedure 2. For departures, the standard-procedure profile is used until reaching the track distance associated with that highest altitude. Altitude controls after that point are followed in order to maintain the subsequent ascent.
- Procedure 3. For arrivals, altitude controls prior to the track distance associated with the highest altitude are followed (in order to maintain an initial descent, for example). The standard procedure profile is followed from the highest altitude to the runway.

^{3/} *NIRS User's Guide*, Version 2.0. Federal Aviation Administration. Washington, D.C. December 2001.

^{4/} *INM Technical Manual*, Version 5.1. Federal Aviation Administration. Washington D.C. December 1997.

^{5/} *Noise Screening Procedures for Certain Air Traffic Actions Above 3,000 Feet AGL*, FAA Notice 7210.360. Federal Aviation Administration. Washington, D.C. September 14, 1990.

Aircraft Stage Length

Stage length is the term used in NIRS to refer to the length of the trip planned for each aircraft operation from origin to destination. The trip length is needed in noise calculations because it influences the take-off weight of the aircraft, which is higher for longer trips, and lower for shorter trips. The great-circle distance is used to calculate a stage length for each aircraft operation. Seven categories for departure stage length and one for arrival stage length are used in NIRS, as shown in **Table E-7**.

TABLE E-7 STAGE LENGTH AND TRIP DISTANCE	
Stage length Category	Approximate Trip Distance (nm)
<i>Departures:</i>	
D-1	Less than 500
D-2	500 to 999
D-3	1000 to 1499
D-4	1500 to 2499
D-5	2500 to 3499
D-6	3500 to 4499
D-7	Greater than 4500
<i>Arrivals:</i>	
A-1	Any distance (3° Approach)

Flight Track Definitions

To determine projected noise levels on the ground, it is necessary to determine not only how many aircraft are present, but also where they fly. Therefore, flight route information is a key element of the NIRS input data. In order to ensure that the NIRS modeling accurately reflects local conditions in the STL area it is necessary to develop noise modeling tracks from a sample of detailed radar data. A 37-day sample of radar tracks from April 27 through June, 2003 was acquired and analyzed for each of the five airports in the MAP study. This detailed information allowed for the development of an exhaustive and rigorous

database of flight tracks for the noise modeling effort.

Exhibit E-1 presents the 37-day sample of radar departure tracks for all five MAP study airports. The sample provided some 20,750 departure flight tracks for analysis. The tracks are shown over the base map of the area and the 75 nautical mile study area boundary is partially shown, along with the Terminal Radar Approach Control (TRACON) boundaries used by air traffic controllers when routing aircraft. As the tracks indicate, a number of commonly used departure routes are evident near the outer TRACON boundary (50 NM). However, in the areas closer in to the city, departure traffic traverses much of the region at one time or another.

Exhibit E-2 presents a similar image with the radar arrival tracks for the MAP study airports. There were some 20,140 arrival tracks included in the sample. Again, the distinct arrival corner posts are evident near the outer TRACON boundary (50 NM). As with the departures, the areas closer in to the city are extensively traversed by arrivals to the five airports.

The Airspace Design Tool (ADT), developed by Metron Aviation Inc., was utilized for the detailed analysis of the radar data for each MAP airport. The data was separated first by airport and then by operation type (arrival, departure). ADT was then used to develop bundles of radar tracks based on runway, aircraft category (jet, prop), and route similarity. The radar bundling process also included a review of the 3-dimensional aspect of each group of radar tracks. Bundles were split as necessary to isolate groups of tracks with restricted climb or descent profiles. Such groups generally represent flights that experienced specific ATC climb or descent procedures. Once the radar track bundles were complete, the development of noise modeling input tracks was initiated.

The ADT program allows for the development of primary, or backbone, flight tracks for each radar track bundle. The system also allows for the simultaneous computation of sub-tracks that are located adjacent to the backbone track.

These sub-tracks account for the dispersion of actual flights about the primary flight corridor based on the distribution of radar tracks within each bundle. The system uses the statistical distribution of the radar track locations along the backbone track determine the spacing between the sub-tracks at that point. The number of sub-tracks developed is determined by the user dependant on the number of radar tracks in the bundle and their general spread thought the route.

The system also computes a weighting factor for each sub-track that allows aircraft operations to

be assigned to the backbone tracks and then automatically distributed to each of the corresponding sub-tracks. This weighting factor is computed based on the average lateral distribution of the radar tracks throughout the bundle with respect to the backbone track position. The resulting distribution generally approximates a "normal", or bell curve, distribution with the highest percentage on the backbone track and progressively lower percentages on the adjacent sub-tracks. The process of the flight track analysis was conducted for each airport and operation type in each direction of flow.

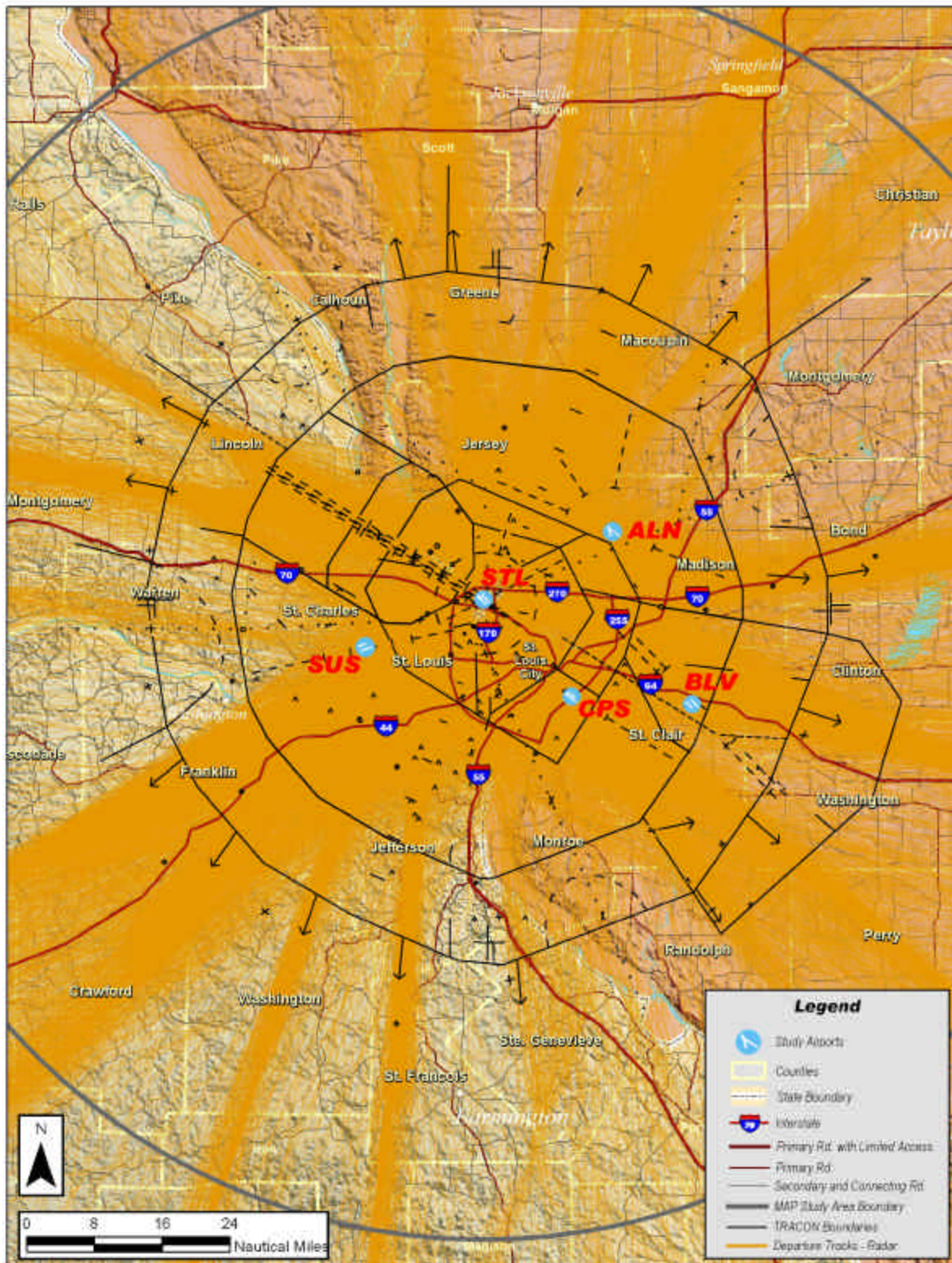


EXHIBIT E-1 DEPARTURE RADAR TRACKS

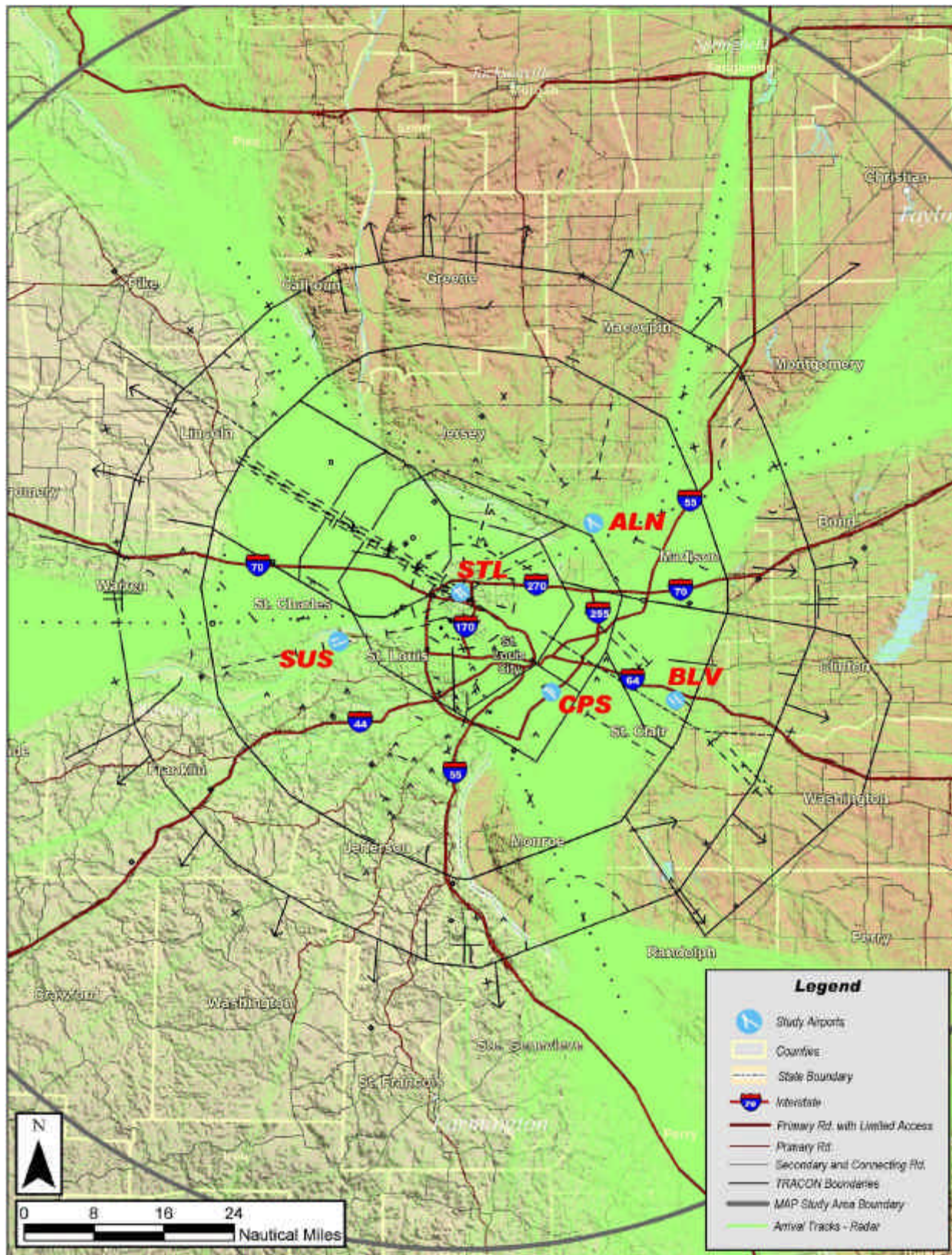


EXHIBIT E-2ARRIVAL RADAR TRACKS

The radar data analysis resulted in the development of some 802 individual backbone departure tracks with 2,102 associated sub-tracks. Thus, some 2,900 unique departure tracks were developed for NIRS model input. **Exhibit E-3** presents an overview of the NIRS departure tracks used in the modeling. The dark red lines represent the backbone tracks with the lighter red tracks indicating the sub tracks. When compared to the radar tracks in Exhibit E-1 it is evident that the resulting NIRS model tracks provide a good representation of the typical flight routes in the St. Louis area.

The analysis resulted in the development of some 705 individual backbone arrival tracks with 2,109 associated sub-tracks. As a result, some 2,800 unique arrival tracks were developed for NIRS model input. **Exhibit E-4** presents the resulting NIRS arrival tracks used in the modeling. The dark green lines represent the backbone tracks with the lighter green tracks accounting for the sub tracks.

It should be noted that because the future (2006 & 2013) conditions at STL include a new runway (11-29) that was not present when the radar sample was acquired, it was necessary to develop new tracks for this runway. The process was relatively simple and straightforward. After the NIRS backbone tracks and sub-tracks were developed from the radar data for the existing runways they were copied and moved to be aligned with the new runway. The copies were then edited to blend into the common arrival and departure flows further away from the airport. The flight track dispersion (sub-tracks) were

generally left the same for the new runway except where the dispersion was no longer realistic given the position of the runway and the predominant routes. In some cases, the geometry of the NIRS tracks for the existing runways was modified to accommodate the position and geometry of the new runway.

Common flight routes to and from an airport are generally a function of the geometry of the airport's runways and the surrounding airspace structure in the vicinity of the airfield. At STL, both the airfield geometry and the surrounding airspace are relatively simple.

The air traffic around STL is routed through what is known as a Four-Post system. This is a system where four specific locations are identified nearly symmetrically around the airport for arriving aircraft to pass over. These points are usually identified by navigational radio beacons such as VOR's or by navigational fixes based on signals from nearby navigational beacons. They are typically situated approximately 30-50 nautical miles from the airfield and are often set up at about a 45-degree angle to the primary runway orientation. These posts allow air traffic controllers to efficiently route four streams of arriving traffic into the vicinity of the airport. In between each of these posts one or more departure fixes are typically defined. When several of these departure fixes are located adjacent to each other they are sometimes referred to as departure gates. These are set based on the structure of the airspace in the area and the common destinations of traffic departing the airport.

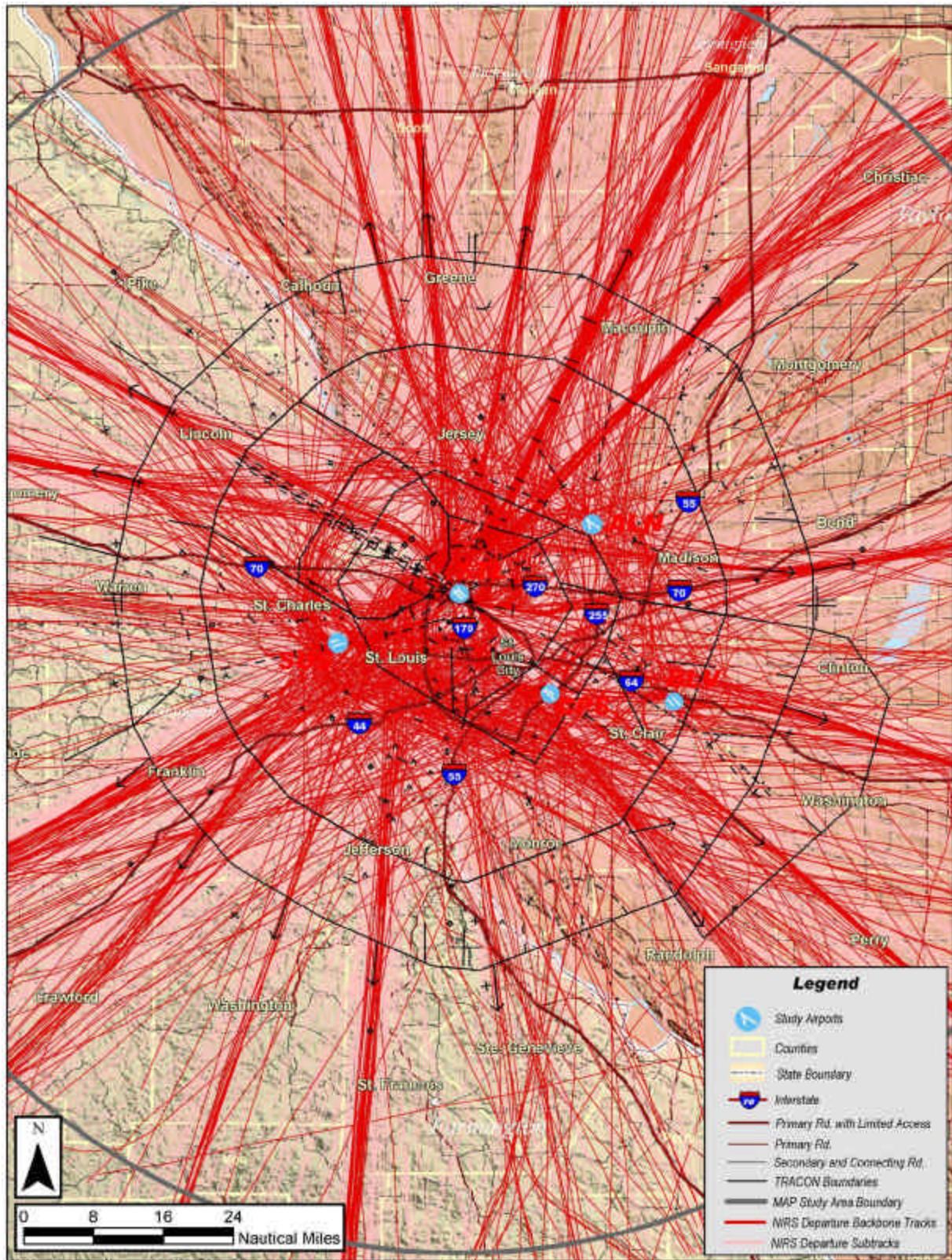


EXHIBIT E-3NIRS DEPARTURE TRACKS

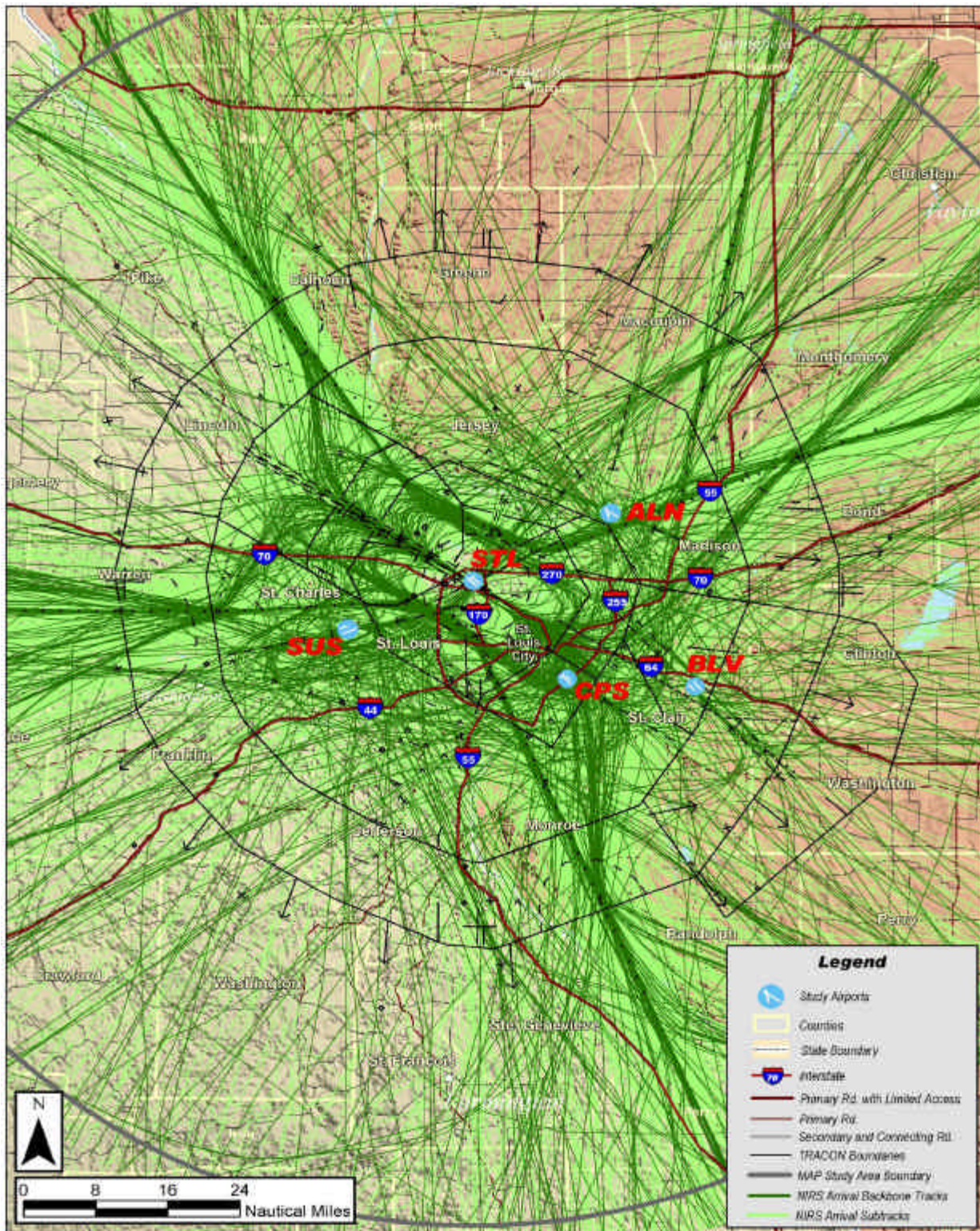


EXHIBIT E-4 NIRS ARRIVAL TRACKS

In the MAP study area, the four arrival corner posts are defined based on the intersection of signals from nearby radio beacons. The posts are situated approximately 50nm (nautical miles) from STL to the northeast, northwest, southwest, and southeast. To the northwest is the LORLE fix that is located about 16 miles west of Bowling Green, MO near Clarksville, MO. The PETTI fix is located to the northeast of STL about 10 miles east of Staunton, Ill, near Sorento, Ill. To the southeast, the QBALL fix is located about 10 miles north of Ste Genevieve, MO. The KAYLA fix represents the fourth corner post for STL. It is located to the southwest about 10 miles south-southwest of Warrenton, MO. **Exhibit E-5** presents the STL NIRS arrival backbone tracks for the east flow (Runways 12L, 12R, & 11) condition to illustrate the locations of the arrival corner posts and the typical arrival flows.

The exhibit also highlights three key elements of the arrival routes to STL. The area highlighted in orange represents what is known as the “downwind” segment for arrivals coming from the opposite direction (PETTI, QBALL - “long

Exhibit E-6 presents the STL NIRS departure backbone tracks for the east flow (Runways 12L, 12R, & 11) condition to illustrate the locations of the departure gates and the typical departure flows. As the Exhibit also indicates, there generally one or more departure gates situated between each of the arrival corner posts. These gates named for ease of use and contain from one to four fixes each. Three of the nine gates shown are for exclusive use by propeller aircraft. These gates have the prefix “Turbo” in their naming scheme

Flight tracks for overflights of the MAP study area were also developed using the method described in the previous paragraphs. The 37-day radar sample provided some 28,000 overflight tracks below an altitude of 18,000’ MSL for the analysis. The effort resulted in the development of some 429 NIRS backbone tracks with 642 associated sub-tracks. Thus, some 1,000+ overflight tracks were included in the NIRS noise modeling. These tracks remained

fixes”) from the runway flow. This traffic then turns into the blue highlighted area and blends with the traffic coming from the short fixes (LORLE, KAYLA). This turn is called the “base” leg of the route. Finally, another turn from the blue area to the final approach highlighted with the yellow box puts the aircraft on the final approach to the arrival runway.

Aircraft departing STL are assigned to a specific initial heading to fly until they are at least five miles away or they have passed through an altitude of 2,500 feet MSL, whichever comes first. At this point ATC will then direct the aircraft to turn toward the desired departure fix. The initial departure headings are standardized as part of ATC's standard operating procedure and were developed a number of years ago to assist in noise abatement near the airport. This standardization is necessary to ensure that adequate safety margins are maintained and that no two aircraft are routed on converging courses. Safety requirements dictate that each adjacent departure heading (jet or propeller) must be separated by at least 15 degrees.

constant for both future years of analysis and all alternatives investigated.

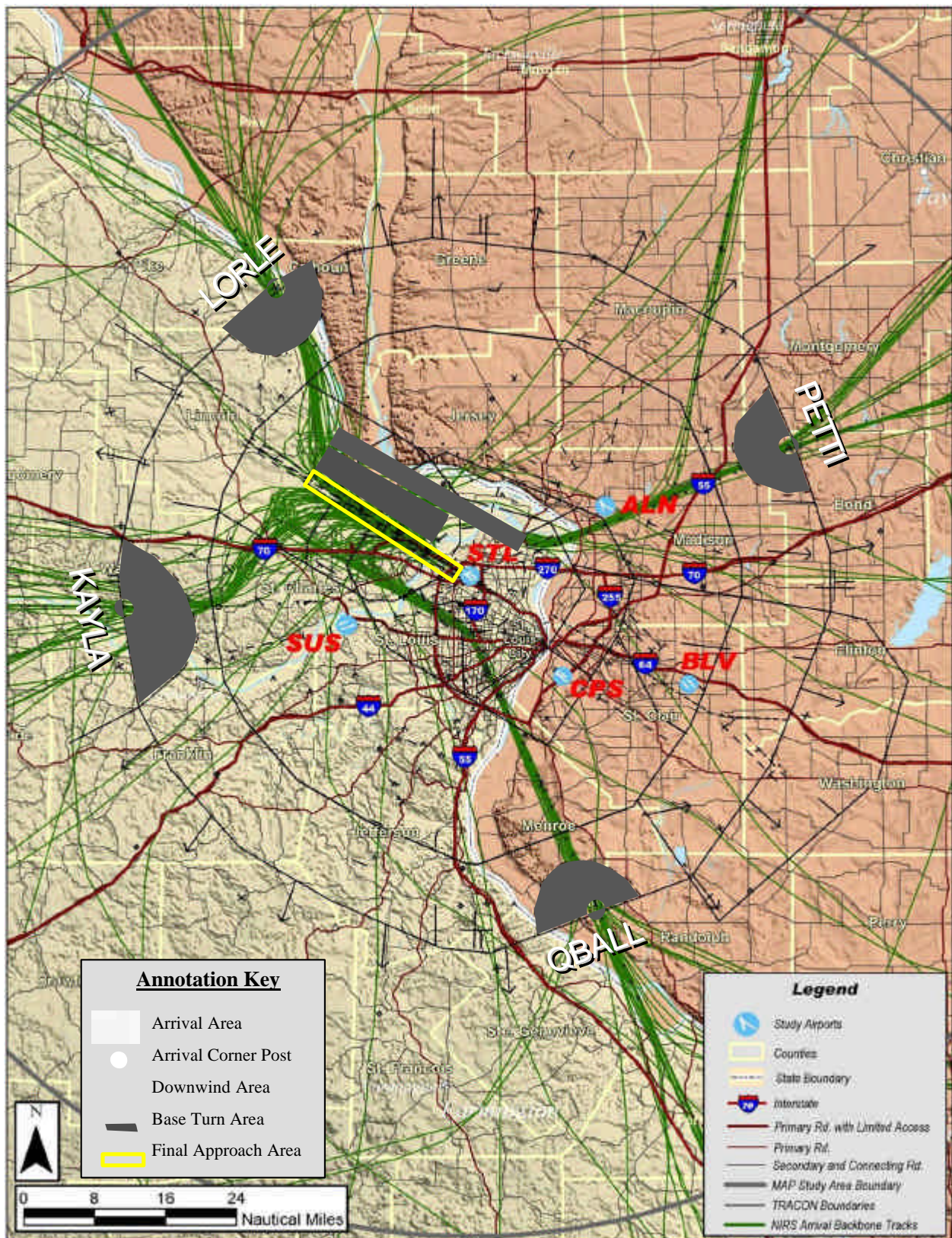


EXHIBIT E-5 STL NIRS ARRIVAL BACKBONE TRACKS – EAST FLOW

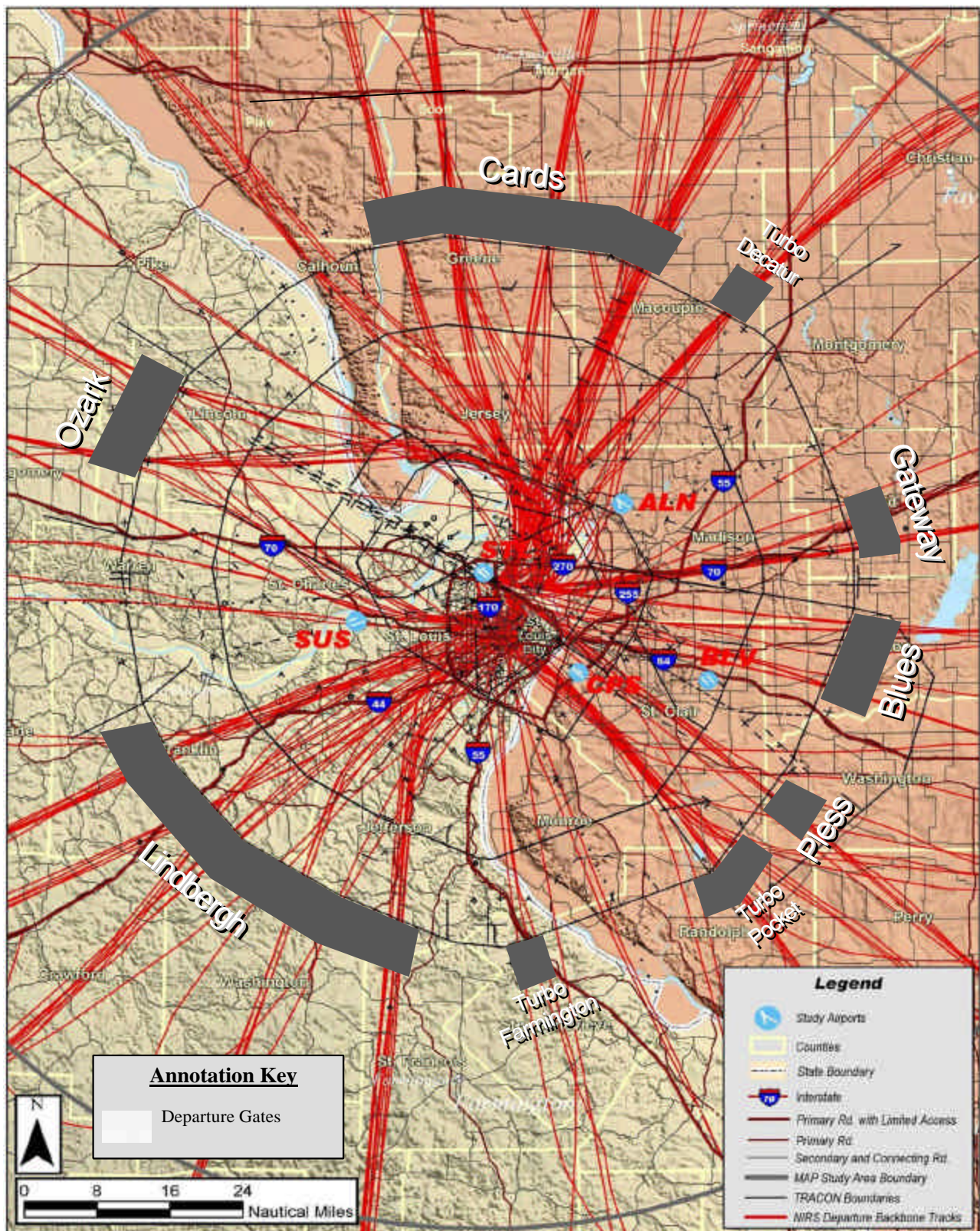


Exhibit E-6 STL East Flow NIRS Departure Backbone Tracks

Flight Track Assignment

The final step in developing the flight track input data for the NIRS model is the assignment of aircraft to specific flight tracks. The radar data sample acquired for the flight track analysis was used as a basis for this analysis. The flight data associated with the bundle of radar data used to make NIRS backbone track was retained as an attribute of each backbone track. This data included aircraft type, time-of-day (day or night), and flight origin or destination.

The flights to be modeled for the future conditions at each airport were provided in the design-day flight schedules. These schedules also included aircraft type, time-of-day, and origin/destination data. Each of the flights in the design-day schedule was parsed into fractions of operations assigned to a specific runway based on the runway use percentages discussed earlier. Once parsed by runway, the flights were then further parsed to each NIRS backbone based on the proportion of radar tracks that match the aircraft category (jet, prop etc.), time-of-day (day or night) and the destination of the scheduled flight. Thus the weighting of the flight tracks and routes was closely tied to the real-world radar data from the STL area. The process of track assignments continued until all scheduled operations, for each airport had been assigned. Once assigned to a specific backbone, ADT then automatically parses the flights further to make the proportional assignments to the sub-tracks associated with each backbone.

Population Data

Population locations were extracted from the 2000 U.S. Census data for the entire MAP study area.^{6/} The census data was incorporated into the analysis at it's most refined level. Known as census blocks, these divisions represent the smallest area within the database where population data is defined. While census blocks vary in size, they tend to represent city block areas in urban zones, and larger areas in rural areas. For this analysis, the geographic center point of each census block in the study area was identified for noise computation. These "centroids" where population values were non-zero numbered some 80,562 within the study area. Forecasts of the expected future population levels in 2006 and 2013 were then developed for each census block. Thus, the estimated future noise conditions are matched to the estimated future population levels within the study area.

Exhibit E-7 shows the study area and extracted population centroids. The centroids are color-coded based on the forecasts 2006 population levels at each centroid. **Exhibit E-8** presents a similar map showing the expected changes in population from 2006 to 2013. A simple color scheme is used to identify areas where population is growing, staying the same, or decreasing by 2013.

^{6/} 2000 Census of Population and Housing, Public Law 94-171. U.S. Department of Commerce, Bureau of the Census, Data User Services Division. Washington, D.C.

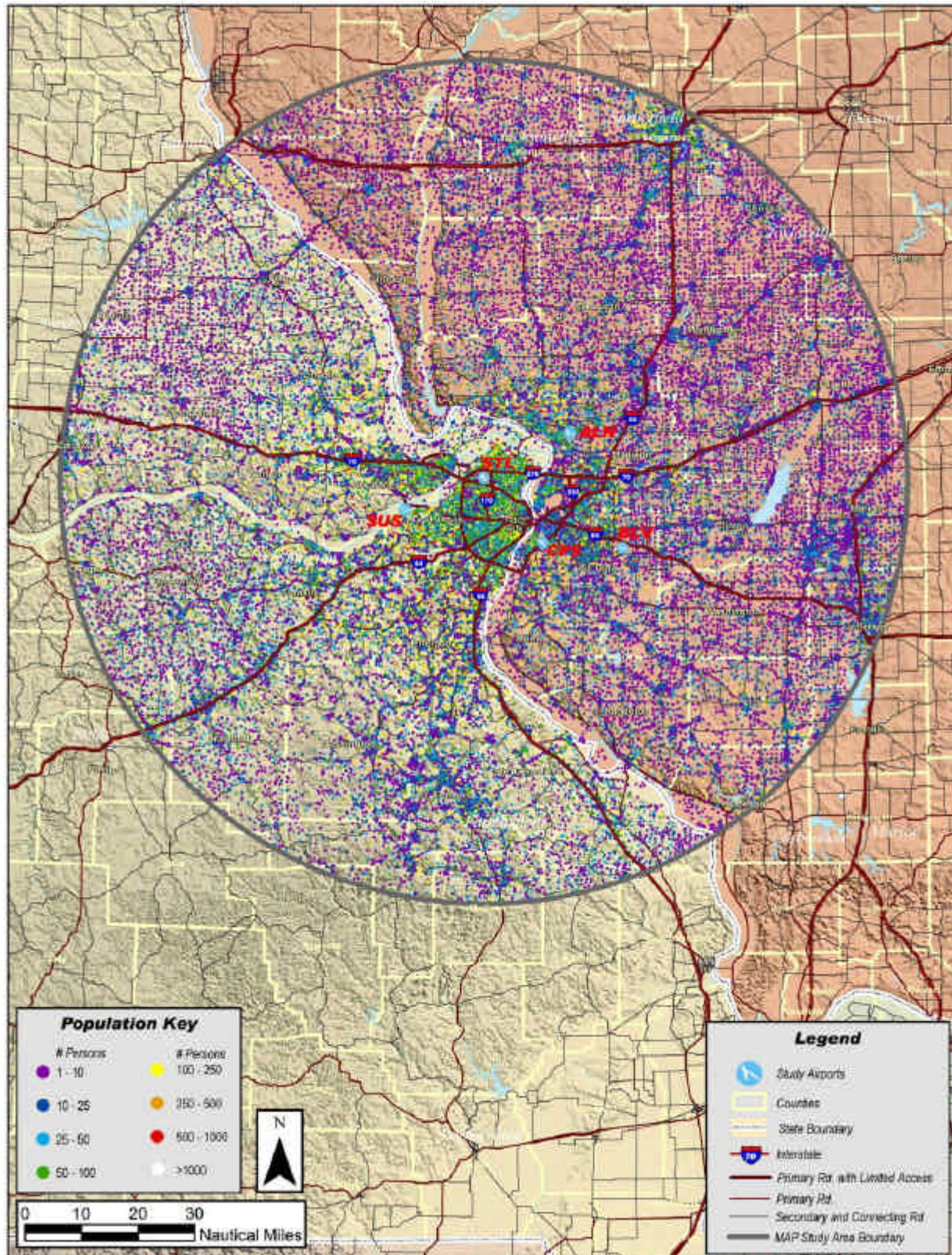


EXHIBIT E-7MAP STUDY AREA POPULATION CENTROIDS & 2006 POPULATION

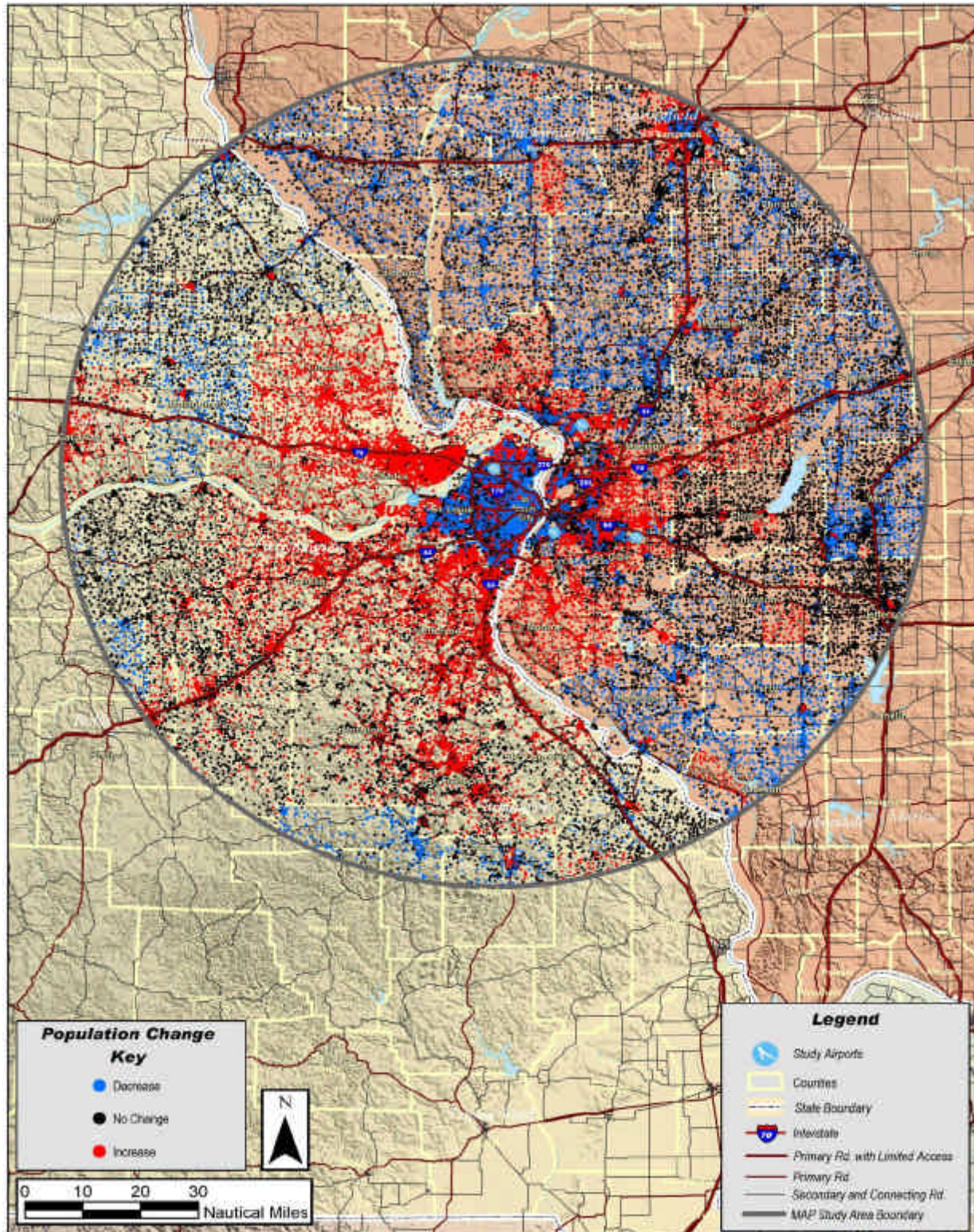


EXHIBIT E-8 POPULATION CHANGE 2006 TO 2013